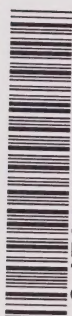


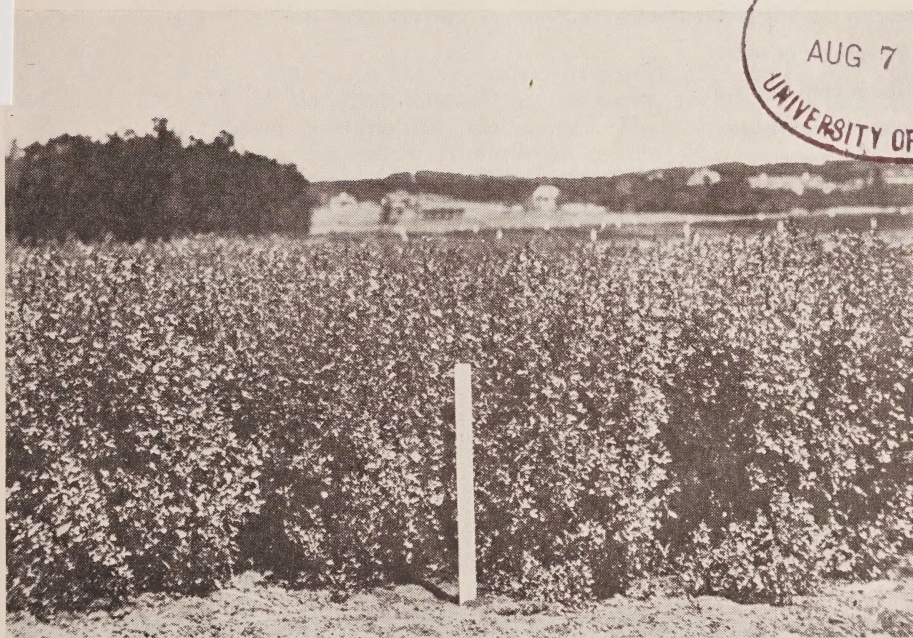
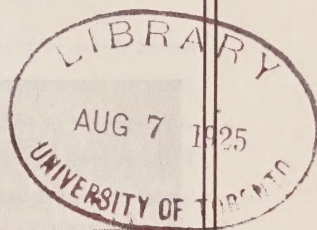
SWEET CLOVER

RESULTS OF EXPERIMENTS
at the
DOMINION EXPERIMENTAL FARM
Brandon, Manitoba

By
R. A. DERICK, B.S.A., M.Sc.



3 1761 12000562 4



Arctic Sweet Clover—A Hardy Biennial Type

DOMINION OF CANADA
DEPARTMENT OF AGRICULTURE

PAMPHLET No. 56—NEW SERIES

DOMINION EXPERIMENTAL FARMS BRANCH
E. S. ARCHIBALD, B.A., B.S.A., Director

Published by direction of the Hon. W. R. Motherwell, Minister of Agriculture,
Ottawa, 1925

TABLE OF CONTENTS

	PAGE
Sweet clover in Manitoba.....	3
Soil and climatic requirements.....	3
An improver of soils.....	3
Place in crop rotations.....	4
Sweet clover for hay.....	5
Pasture crop.....	5
Growing for seed.....	6
Varieties.....	6
Silage.....	7
Cultural practices.....	7
Dates of seeding.....	7
Rates of seeding.....	8
Depth of seeding.....	8
Nurse crops.....	9
Rates of seeding wheat as nurse crop.....	10
Methods of harvesting.....	11
Cutting and curing.....	12
Sweet clover in mixtures.....	12
Sweet clover in inter-tilled rows.....	14
Inoculation.....	14
Summary.....	15

SWEET CLOVER

By R. A. DERICK, B.S.A., M.Sc.

SWEET CLOVER IN MANITOBA

The popularity of sweet clover as a farm crop for Manitoba has quite recently become well established. According to the report of the Manitoba Department of Agriculture, there were 94,844 acres of this crop under cultivation in the province in 1924. This figure represents over 17 per cent of all the grasses and clovers grown for hay and pasture, exclusive of native prairie grasses. The following figures represent the Manitoba acreages of the more commonly grown hay crops in 1924 as compared with sweet clover.

Western rye grass.. . . .	15,250 acres
Brome grass.. . . .	98,296 "
Timothy.. . . .	84,745 "
Alfalfa.. . . .	7,715 "
Sweet clover.. . . .	94,844 "
Other clovers.. . . .	7,988 "

The ability of this legume to thrive under diverse conditions of soil and climate, and the value of the crop for soil improvement, for pasture and for hay, have all contributed towards its popularity. There has always been, however, a certain prejudice against sweet clover on account of its coarse, woody stems, its aggressiveness in waste places, and its bitter taste.

The repeated demand for information regarding the culture of this crop in this province has prompted the preparation of this pamphlet. It is proposed to present the results of the experiments at the Dominion Experimental Farm, Brandon, and to discuss other points in connection with this crop. The data from this Farm cover only a few years' work, but it is possible to make certain deductions from the evidence obtained from these experiments and from information gathered from other sources.

SOIL AND CLIMATIC REQUIREMENTS

Sweet clover, like most other cultivated plants, thrives best on good, well-drained and well-prepared soils. It grows, however, on almost any soil, and for this reason, it is possible to make the poorer fields on the farm give reasonable returns. The ability of this plant to thrive on poor soil is due mainly to the rapid growth of its extensive root system, and to the fact that it is able to draw upon the air for its nitrogen requirement.

The environmental conditions which seem detrimental to the proper development of sweet clover are two; lack of lime, and poor drainage. The plant will, however, withstand poor drainage conditions better than most other legumes. It is also claimed by some that this crop is partially resistant to concentrations of salts and to soil alkalinity.

Observations at the Brandon Farm indicate that sweet clover does not there suffer from winter injury to any great extent. It would also seem that this crop is more able to resist spring frost injury than other commonly cultivated legumes and that it is more drought resistant.

AN IMPROVER OF SOILS

Probably one of the most valuable qualities of sweet clover is its ability to improve soils. Being a legume, it has the ability to extract free nitrogen from the air, and incorporate it into its tissues. Much of the soil in Manitoba has become deficient in organic matter through the practice of continuous grain growing. The result has been that the lighter soils have become less productive, more subject to drifting, and have a lower water-holding capacity.

Nitrogen is one of the most essential plant foods as well as the most expensive. Sweet clover offers promising indications as a cheap source of nitrogen. It thrives on poor soils, and produces an abundance of large, fleshy roots. These roots decay very readily, supplying organic matter to the soil, improving the texture and providing better drainage and aeration.

It is reported by the University of Illinois,* that the amount of nitrogen per ton of water-free sweet clover tops, taken in the spring, the year following seeding, averaged 87.6 pounds. It is also stated that the roots weigh as much as or more than the tops at this time of the year, and that the nitrogen content in the roots is not much lower than that of the tops. When the clover reached a height of 26 inches, a yield of 2.43 tons of tops (water-free basis) contained as much nitrogen as 20 tons of average farm manure.

IN CROP ROTATIONS

It would appear that if grain growing is to be continued on the prairies as the basic agricultural industry, it will be necessary to establish some systematic arrangement of crops so that the grains can be alternated with grasses and clovers in order that weeds, plant diseases and insect pests can be effectively controlled. Because of its heavy tonnage when cut for hay, and its greater carrying capacity when used as pasture, sweet clover gives promise of becoming very useful when grown in crop rotations with grains, either when sown alone or in mixtures with grasses. It has a decided advantage over western rye grass and brome grass in being a leguminous crop. Instead of depleting the soil of nitrogen, as is the case with the grains and grasses, it stores up atmospheric nitrogen in the soil for its own use and for succeeding crops. How frequently sweet clover, or a mixture of sweet clover and grass, will have to be used to replace the grain crop in order to maintain the nitrogen supply in the soil, will depend on the condition of the soil. Where clover is grown once in from three to six years, the nitrogen content of the soil is likely to be maintained and possibly increased.

Since the common practice under most conditions where a definite cropping system is followed is to have one field for each crop, and as most Manitoba farmers prefer large fields, it would seem that a rotation of from three to six years would be most satisfactory. The following may be suggested as an outline for a rotation that could be used on a stock farm, or on a portion of a grain farm near the buildings, to furnish pasture and hay for work horses, milch cows, etc. This rotation is tabulated as follows:—

- 1st year—Summer-fallow.
- 2nd year—Wheat (half area seeded down to sweet clover).
- 3rd year—

{	Half field—coarse grain.
	Half field—sweet clover.

The farm is divided into three fields, one-third summer-fallow, one-third wheat (half seeded down to sweet clover) with the rest of the farm in coarse grains and sweet clover. After the first cycle of the rotation had been completed, which would cover a period of three years, the sweet clover would then be grown on the half of the field which had had no clover the previous cycle. Where more forage is required than would be obtained from the sweet clover, part of the summer-fallow field could be used for corn or some other fallow substitute.

Where pasture for the entire season is required, and a large number of animals have to be fed, early spring seeding of sweet clover with a light nurse crop of oats would provide considerable pasture from mid-summer to autumn. A suggestive rotation, making use of sweet clover to supply large amounts of pasture, is outlined on page 5.

* Bulletin No. 233, University of Illinois, 1921.

- 1st year—Sweet clover sown with oats in early spring.
- 2nd year—Pasture ploughed up in mid-summer.
- 3rd year—Wheat.
- 4th year—Oats.
- 5th year—Corn.

In this cropping system, three-fifths of the farm is in forage crops each year. If hay is required, sweet clover could be used for this purpose. The sweet clover pasture could be ploughed up in mid-summer, and thus allow for some clean cultivation in preparation for wheat. Every field on the farm receives the benefits of a leguminous crop once in four years, as well as the nitrogen supplied to the soil during the seeding-down year.

SWEET CLOVER FOR HAY

There has always been some diversity of opinion with regard to the value of sweet clover for hay, and while it is generally considered to be quite palatable and nutritious if cured at the proper stage, it is safe to say that it is more difficult to cure and less palatable than alfalfa. The leaves dry up much more quickly than the stems, with the result that by the time the crop is dry and ready for storage, a large proportion of the leaves will have been shattered through handling. Since the spring growth is very rapid, the first cutting is usually ready before the weather has become settled, and proper curing is therefore made more uncertain. When grown on very rich soil, the growth is likely to be rank and coarse, the plants often reaching a height of two to four feet even before the buds appear. Hay made of this coarse material will cure with difficulty and make poor hay. Under these conditions, it might be well to clip the crop back earlier in the season. If clipped back in this way, leaving rather a high stubble, the quality of the crop can be greatly improved by forcing a new growth of finer shoots from the basal stems.

The bitter flavour in the leaves of sweet clover, due to its coumarin content, is objectionable, but not sufficiently so to interfere to any great extent with its feeding qualities. A considerable quantity of this coumarin is liberated during the process of curing.* While some animals do not relish sweet clover hay at first, feeding trials have demonstrated that cattle acquire an appetite for this hay, provided it is not too coarse and has the bright green colour indicative of good curing. At this Farm, it is interesting to point out, that sheep, having access to coarse sweet clover hay harvested in sheaves, as well as corn silage, have shown a decided preference for the clover, and continued in excellent condition throughout the winter. They did not eat the coarsest stems.

PASTURE CROP

With few exceptions, sweet clover seems to have given excellent results as a pasture crop. On the Experimental Farm at Brandon, while no definite feeding trials have been made, cattle have been pastured on this crop with no apparent ill effects. The milk supply was completely maintained and no complaints were received reporting the odour or flavour of the milk as being disagreeable. The condition of the animals was not in any way affected. Other reports from different parts of the province have been equally favourable.

There is no doubt, however, that this clover makes an extremely soft feed when used alone, and it is advisable to give the animals access to some form of dry roughage. Unless the crop is kept well pastured down, the growth may become rank and coarse and less palatable. Furthermore, some of the plants may ripen seed, and produce volunteer plants after the pasture is ploughed up. In the more moist sections, sweet clover may re-seed itself and thus help to maintain a permanent stand, if such is desired.

*Journal of American Society of Agronomy, Vol. 16, No. 3, p. 182.

As a hog pasture, sweet clover has gained a certain distinction. It is often possible to turn the hogs on during the latter part of the seeding-down year, or as soon as the plants are 8 or 9 inches high, and whether a nurse crop is used or not, considerable feed should be available. Close pasturing late in the fall is not desirable, for it is preferable to leave some growth for winter protection.

Sweet clover is able to withstand the effects of pasturing somewhat better than alfalfa, and for this reason, and also because of its rapid recovery, it is possible to utilize the first year's crop.

GROWING FOR SEED

It is well known that this crop is an abundant seed producer, but on account of its aggressiveness and persistency, the production of seed has not received the desired amount of attention.

Fairly good yields of seed are reported, ranging from 3 to 15 bushels per acre. The seeds ripen very unevenly, and it is necessary to cut the crop before all the pods are brown in order to prevent too much loss through shattering. The green, immature seeds can be removed in the cleaning process. Cutting can be satisfactorily done with the grain binder, provided the crop is not too tall and coarse. In threshing, unless a huller is available, it is desirable to leave as many of the hulls on as possible, for this enables a more thorough weed seed separation when cleaning.

Like other clovers, sweet clover seed contains a certain proportion of hard seeds. It is necessary to rupture the seed coats of these before they become permeable to moisture and capable of germination. There is a special machine on the market for the purpose of scarification, plans of which may be procured from the Dominion Experimental Farm at Brandon. There are also some home-made devices which give satisfaction, provided the quantity of seed to treat is not too great. If the seeds are forced by air pressure against a rough surface such as sandpaper, their seed coats will be scratched sufficiently to allow the absorption of the water necessary for germination.

VARIETIES

There are a large number of so-called sweet clover varieties, many of which are quite indistinct. There are annual and biennial white, as well as annual and biennial yellow-blossoming varieties. At the present time, however, the demand is mainly for the biennial white type, commonly referred to as merely white sweet clover. The main distinguishing characteristics between the common biennial white and yellow sorts are blossom colour and habit of growth.

The biennial yellow is a somewhat smaller-growing earlier-maturing variety, having more tillers, and a finer stem and leaf growth. It is not grown to any great extent, probably because it is usually believed to produce less forage than the common white-blossomed varieties. It seems equally as hardy if not hardier than the white types.

Arctic is a white-flowered, biennial variety developed at the University of Saskatchewan. The first seed of this variety planted in Canada had its origin in northern Siberia. It is generally accepted that Arctic possesses superior hardiness, but since all biennial types of sweet clover tested at this Farm have proven hardy, it is not surprising that no difference has been noted in the winter hardiness of this variety. In maturing, Arctic is probably slightly earlier than the common white.

Hubam, a white-flowered annual variety, seed of which has been distributed by the Iowa State College, is capable of producing seed in one year. This variety has received considerable attention of late, and has been tested under many and varied soil and climatic conditions. Tests at this Farm have shown

that it requires a long season in which to reach full maturity, and that the average growing season in this province would not allow for full development of the crop. It grows rather slowly early in the season, but later on produces a quick, rank growth and may prove useful ploughed under as a green manure.

SILAGE

It is generally true, that any of the common legumes can be made into silage. The result of tests both in Canada and the United States have confirmed this point. It is claimed that sweet clover makes equally as nutritious a silage as alfalfa. The tonnage of both these crops, however, is usually too small to recommend their general use for this purpose.

The amount of moisture in the legumes as cut for hay, is usually high, and if silage is made of this green material it is likely to become slimy. For this reason, when these crops are to be ensiled, it is advisable to let them become slightly more mature than when cut for hay.

It has been reported that good silage has been made by stacking the green sheaves of sweet clover. There is not enough evidence in support of this practice to warrant more than a reference to it, for when green hay is stacked in this way, decomposition rather than fermentation takes place.

CULTURAL PRACTICES

The increased acreage of sweet clover in Manitoba has made it important that experimental data be obtained concerning the best methods of seeding the crop; the most desirable time to cut for hay; the height at which the stubble should be cut in order to secure the best yield from the second cutting; and other questions relating to cultural practices. Many of these problems have a direct bearing on the successful growing of this crop and its profitableness. The results of the experiments reported on in the succeeding pages throw some light on these problems.

It should be pointed out that these experiments have been conducted on fairly rich, heavy, loam soil in the Assiniboine valley, and consequently the results may not altogether apply when the crop is grown on lighter soil.

DATES OF SEEDING

Since moisture is to a large degree the determining factor in crop production in Manitoba, it is ordinarily good practice to seed as early as possible and yet escape spring frost injury. When seeding with a nurse crop, early seeding becomes even more important. Unless the young seedlings of sweet clover get well established before the first drought, they may receive a set-back from which they will not fully recover. When the clover is to be seeded without a nurse crop, early seeding is not so important. When seeded early it may be possible to harvest a crop of hay the first season, or secure some fall pasturage.

While the results of experimental work at the Brandon Farm on dates of seeding sweet clover favour the earlier seedings, the increased yield is hardly sufficient reason for recommending this practice. It is advised as a precaution against drought. The average yields for two successive years from three different dates of seeding, with a nurse crop of wheat sown at the rate of 5 pecks per acre, are given in table 1.

TABLE 1.—DATES OF SEEDING

Date Seeded	Yield of cured hay per acre	
	tons	lbs.
May 10.....	3	500
“ 20.....	3	460
“ 30.....	3	350

A common practice is to use wheat as a nurse crop in seeding down sweet clover, and since the yield of wheat responds favourably to early seeding, it seems advisable to get these crops established as quickly as the soil will permit in the spring.

RATES OF SEEDING

The data available seem to indicate that the yields of sweet clover are not influenced to any great extent by a heavy rate of seeding. The number of plants that a given area of soil can support is limited, and although it is possible to improve the quality of the crop by thick seeding, the total yield will not be greatly increased. There are, however, a number of factors that will influence the amount of seed to sow, and these relate to soil conditions and quality of seed. With poor soil and a loose seed-bed, it would be advisable to seed a little more thickly. The fact that much of the seed is put into the ground without being hulled or scarified makes it necessary to use more seed. On the other hand, less seed will be required when the crop is to be harvested for seed, and also when grown in intertilled rows.

At the Brandon Experimental Farm, tests have been made for two years with different rates of seeding sweet clover. In 1923, the test included seedings of 6, 9, 12, and 15 pounds per acre. In 1924, two more plots were added, and these were seeded with 20 and 25 pounds per acre respectively. Table 2 gives the results.

TABLE 2.—RATES OF SEEDING SWEET CLOVER

Rate of Seeding lbs.	Yield of cured hay per acre	
	1923	1924
	tons lbs.	tons lbs.
6.....	3 1,680	3 1,110
9.....	3 1,640	3 1,758
12.....	3 1,920	3 1,839
15.....	4 80	3 1,767
20.....	— —	3 1,776
25.....	— —	3 1,803

The results show that there has been no significant increase in yield by seeding at a heavier rate than 12 pounds. It will be noted, however, that the difference in yield between seeding 6 and 25 pounds in 1924 is 693 pounds, but that there has been very little increase brought about by seeding more than 12 pounds. In 1923, there was an increase of 400 pounds favouring the 15-pound seeding over the 6-pound. The fact that no significant increases were obtained by seeding more than 12 pounds has been further exemplified by counting the actual number of plants on given areas in each plot. It was found that there were equally as many plants per square foot with the 12-pound seeding as with the 25-pound. While these results are only indicative, due to the short duration of the experiment, yet they confirm the work of others on this problem.

DEPTH OF SEEDING

When seeding sweet clover with a nurse crop, it is a common practice to mix the clover with the grain in the grain box. When this is done, all the seeds will be more or less at the same depth in the soil. The grain will germinate quickly, breaking its way through the soil surface, making it easier for the more delicate clover seedlings to reach the surface. If the soil is heavy, however, the young clover plants may take so long to reach the surface that the competition of the nurse crop together with the weeds may become too great for the best development of the young seedlings.

When the grass and clover seeder attachment is used, and the seeds scattered in front of the grain drills, there will not be as uniform a depth of seeding. Some of the clover seeds will probably be covered as deeply as the grain, while others will be left near the surface and covered only by the chains. Those seeds that were covered deeply may not germinate and get above ground until it is too late for them to have an equal chance of establishing themselves along with their neighbors. It is safer to make sure that the majority of seeds reach the soil moisture, and yet are not covered too deeply to cause delayed germination or difficulty in reaching the surface. Extra cultivation prior to seeding, may be necessary to bring the moisture closer to the surface. The use of the packer to firm the seed-bed and thus raise the level of the soil moisture will help to insure a good catch of clover.

At the Brandon Experimental Farm, an experiment in depth of seeding sweet clover has been under way for two years. The results are given in table 3.

TABLE 3.—DEPTH OF SEEDING

	1 inch		2 inches		3 inches	
	tons	lbs.	tons	lbs.	tons	lbs.
1923 yield per acre.....	4	160	—	—	3	1,920
1924 yield per acre.....	3	1,947	3	1,922	3	1,769

The results favour slightly the shallower seedings. This may be partly due to the plentiful moisture supply during the germinating periods in these two years, resulting in the shallow seedings becoming more quickly established, and thus better able to withstand the competitive influence of the nurse crop during drought periods.

The two factors, then, mainly influential in affecting the depth of seeding, are texture of soil and moisture supply. If these two conditions are satisfactory, shallow seeding will probably in the long run give better results. If, however, dry weather conditions prevail during the seeding and germination periods, and if the seed-bed is not mellow and firm, some means of satisfying the requirements of the small seed should be used either by further surface cultivation or possibly slightly deeper seeding.

NURSE CROPS

In discussing the kinds of nurse crops for sweet clover, the experimental results obtained are significant. Four different nurse crops have been tested with sweet clover, in an effort to determine which combination gives the most desirable returns. A standard rate of 10 pounds per acre has been used in seeding the clover, while with the exception of flax, less than the normal rate of seeding has been used with the nurse crops. The results of the experiment to-date are here tabulated:

TABLE 4.—NURSE CROPS

Kind of Nurse Crop	Rate of seeding nurse crop	Average yield per acre for 2 years			
		Seeding down season		Cured hay 2nd season	
	pecks	bush.	lbs.	tons	lbs.
Wheat.....	5	40	0 wheat	3	436
Oats.....	8	110	20 oats	2	1,803
Barley.....	5	72	24 barley	3	26
Flax.....	2	26	14 flax	3	1,417
Sweet clover sown alone.....	—	tons	lbs.	3	1,493
		2	1,380 hay		

The most interesting point brought out in the tabulated figures is that sweet clover can be produced more economically when a nurse crop is used than when grown alone. This is clearly illustrated when the value of 2 tons 1,380 pounds of sweet clover (yield the first year when sown alone) is compared with the value of the various yields of the nurse crops. It must be remembered, however, that this test was conducted on comparatively heavy clay loam, fairly retentive to moisture, and consequently the competitive action brought about by the use of a nurse crop is not so evident as would be the case on poorer soils.

From the excellent yields of the nurse crops, it would seem that the competition from the sweet clover had been negligible. It is also shown that the increased yield of clover the second year, grown without a nurse crop, is insignificant. When comparing the yields of clover following the different nurse crops, it appears that flax has the least detrimental effect on the second-year crop. Flax, however, does not make a desirable nurse crop for sweet clover, because it produces so little shade that the clover is not retarded in its growth, usually reaching a height that makes the handling of the flax difficult, and producing a coarser crop the following year. In this respect the sweet clover yield is very much the same as when the crop is seeded alone. The results indicate that any of the common cereals make desirable nurse crops, and the choice will be governed by the requirements. Wheat is possibly more dependable because of its strength of straw and the fact that its leaves shrivel earlier in the season, allowing more light to reach the young clover plants. There is, however, sufficient shade produced by the wheat plants to prevent any excessive growth of the clover the first year, thus making the nurse crop easy to harvest.

The use of a nurse crop is also beneficial from the standpoint of winter protection. The stubble tends to hold the snow, and the results at this Farm show little or no winter killing on the stubble plots, while approximately 5 per cent of the stand was killed on the plots sown alone. It has been observed that the coarsest and least palatable hay is harvested from the plots sown without a nurse crop. This is probably due to the rank growth of the crop during the first year. The percentage of leaf on the clover crop grown with wheat, oats, and barley, averaged 34.4 per cent, while the plots sown alone averaged 31.2 per cent. While these figures do not show any marked difference, yet they indicate that the quality of hay is lowered when sweet clover is seeded without a nurse crop.

RATES OF SEEDING WHEAT AS NURSE CROP

When wheat is used as a nurse crop for sweet clover, the growth of the clover the first year as well as the stand will be affected in no small degree by the rate of seeding the wheat. There is no reason to expect a greater yield of wheat by heavier seeding, and on the other hand, it would seem natural that the clover would make the most favourable response with the lesser amount of competition offered by a thinly-seeded nurse crop.

From the experimental data obtained, these points are brought out quite clearly. The clover was seeded at the rate of 10 pounds per acre.

TABLE 5.—RATES OF NURSE CROP SEEDING

Rate of seeding nurse crop per acre	Average number plants per 4 sq. ft.	Per cent leaf	Average yield of wheat per acre 1922-23		Average yield of cured hay per acre 1923-24	
			bush.	lbs.	tons	lbs.
Wheat—						
3 pecks.....	17.5	32.4	37	40	3	1,198
5 ".....	17.0	31.5	41	0	3	1,004
7 ".....	16.0	30.2	40	10	3	890
9 ".....	12.5	27.5	41	20	3	528

It will be noticed that the wheat yields are extremely uniform, except with the lightest seeding. There is no significant increase with a seeding heavier than 5 pecks, which is the recommended rate for Brandon conditions. There is, however, a gradual falling off in the yield of hay from the light seeding of wheat to the heavy seeding. The difference in favour of the light seeding represents approximately 10 per cent over the heaviest.

In checking up these differences in yield by counting the actual number of plants on a given area in each plot, figures were obtained which show that the same relation exists, but is more pronounced.

It is also evident that the thick seeding has resulted in the coarsest hay. While the figures only show about 5 per cent greater leaf development on the thinly-seeded plot, yet this is significant when it is remembered that the feed value of sweet clover is, to a large extent, in the leaves.

METHODS OF HARVESTING

The stage of maturity at which sweet clover is cut is one of the main factors determining the quality of hay produced. It is generally recognized that even under the best conditions of harvesting and curing it is almost impossible to produce sweet clover hay equalling in palatability other legume hays. This makes it necessary to exercise extreme care and to practice the best possible methods in handling this crop for hay.

The results of an experiment conducted in 1924 present some interesting figures and throw some light on this problem. In this experiment, the clover was seeded at the rate of 10 pounds per acre, without a nurse crop. A fairly good crop of hay was taken off the first year. In the second year, the eight plots included in the test were cut at three different stages of maturity, and at each stage the crop was subjected to cutting at different heights. Two cuttings were harvested, the second being cut at a uniform height. Following are the results:—

TABLE 6.—TIME AND HEIGHT TO CUT SWEET CLOVER

Stage of maturity	Height of cutting		Per cent leaf	Yield of green hay per acre					
	1st cut.	2nd cut.		1st cut.		2nd cut.		Total	
	inches	inches		tons	lbs.	tons	lbs.	tons	lbs.
Early bud formation.....	4	4	32·7	9	1,920	10	200	20	120
" "	7	4	32·7	9	0	10	1,400	19	1,400
75 per cent terminal buds formed.....	4	4	32·4	11	800	9	0	19	800
" " "	7	4	32·4	11	720	10	800	21	1,520
" " "	10	4	32·4	10	1,680	11	400	22	80
35 per cent in bloom.....	4	4	22·5	16	1,680	1	80	17	1,760
" "	7	4	22·5	16	1,280	1	136	18	640
" "	10	4	22·5	16	400	2	720	18	1,120

It is interesting to note, that there is a general increase in yield as the crop becomes more mature. With this increased yield, there is a gradual decrease in percentage of leaf, showing that the crop becomes more woody and fibrous as it advances in maturity. Stubble cut 4 inches high at the first cutting has given a higher yield than when cut at 7 or 10 inches. This is only what would be expected; but the yield-reducing influence of close cutting on the second crop is apparent.

Low cutting, at 4 inches, in the early bud stage has had the effect of reducing the second crop to the extent of 1,200 pounds per acre. At a later stage of maturity, or when 75 per cent of the terminal buds are formed, the effect of

the lower cutting is more pronounced. By cutting at 4 inches, the yield has been reduced by nearly $1\frac{1}{2}$ tons per acre over the 7-inch cutting, while with the 10-inch cutting the yield is even higher. This shows that low cutting is decidedly detrimental to the yield of the second crop, for the reason that the lower shoots, which produce the second crop, have been clipped off and do not produce as vigorous a growth.

When the first crop is left standing until it is 35 per cent in bloom, the second crop will not be worth cutting. The second crop yields, although very small, are in the same proportion as those of the earlier cuttings, and show that low cutting is injurious to the lower branches which produce the second crop.

As stated above, the second growth of sweet clover, unlike alfalfa, comes from the lower branches of the plants. For this reason, if a second crop is required, it is desirable to cut the stubble high enough to escape injuring the lower shoots or buds. If the first crop is cut early, or at the time of bud formation, it seems inadvisable to cut the stubble higher than 5 inches. If however, the crop is left standing much longer than the bud-formation stage, the yield of the second crop will be in direct proportion to the height at which the stubble is cut, and will likely be small.

The question as to the advisability of taking two cuttings of sweet clover in the cropping year will be determined by the requirements for hay and pasture. With some cropping systems, hay may be the prime requirement, while under other systems, fall pasturage or ploughing after the first crop has been removed and partial summer-fallow may be more desirable.

CUTTING AND CURING

Harvesting sweet clover for hay with the binder has proven satisfactory on this Farm. As the leaves constitute the most desirable part of the hay, it is important that as many of these be preserved as possible. When cutting with the mower, the crop has to be left in the swath for several days in order to partially dry out the coarse stems. During this period, the leaves become so dry and brittle, that only a small proportion are retained by the time the crop is cured. When the tedder is used, better results may be obtained, provided there is good weather. In wet weather, curing in the swath is practically impossible. The high water content of the stems, and the slowness of drying out, make conditions excellent for the growth of moulds. Sweet clover hay, spoiled in this way, has been reported as having caused cattle poisoning in certain parts of Minnesota, North Dakota and Ontario.

When cutting sweet clover with the binder, it is well to tie the sheaves rather loosely and make them small. This allows for more rapid drying out and lessens the possibility of mould development in case of wet weather. If long narrow stooks are made, they will cure in about 15 to 20 days of good weather. A much larger proportion of leaves is saved by binding the crop, as only the outside and top of the sheaves are subjected to much shattering. Since dry weather cannot be depended upon during the period of harvesting the first crop, the binder method seems most satisfactory. Stacking in the ordinary way as with grain, where storage is not available, is a good practice. It is well to cover the top of the stack with hay, for the reason that sweet clover, like other legumes, does not shed water readily.

SWEET CLOVER IN MIXTURES

In selecting grasses and clovers for hay and pasture mixtures, it is necessary to choose those that are able to compete with each other satisfactorily, and are ready to cut at the same time. Sweet clover is so aggressive that some grasses are unable to recover their normal state of development after the clover has completed its life cycle.

In a test covering a period of three years, sweet clover has been grown with some of the more common grasses for the production of hay. These mixtures were seeded without a nurse crop in 1921 on fairly heavy soil. The results are presented in table 7.

TABLE 7.—SWEET CLOVER IN MIXTURES

Mixture	Rate of seed- ing 1921	Total yield of dry hay per acre						Average 1922 and 1923	
		1922		1923		1924			
		lbs.	tons lbs.	tons lbs.	tons lbs.	tons lbs.	tons lbs.	tons lbs.	
Sweet clover and western rye.....	6:6	5	1,600	2	1,800	No crop	4	700	
Sweet clover and brome grass.....	6:6	5	680	2	360	1 114	3	1,520	
Sweet clover and meadow fescue.....	6:6	5	440	1	1,240	0 1,267	3	840	
Sweet clover and timothy.....	6:4	4	1,640	3	840	No crop	4	240	
Sweet clover, brome and western rye.....	6:3:3	5	440	4	520	1 862	4	1,480	
Sweet clover, timothy and western rye.....	6:2:4	5	600	3	960	1 526	4	780	
Sweet clover alone.....	10	5	880*			—	—	—	
Brome alone.....	12	3	1,800	2	320	1 1,720	3	60	
Western rye.....	12	3	560	1	960	No crop	2	1,380	
Meadow fescue.....	12	1	240	0	1,200	2 320	0	1,720	
Timothy alone.....	6	2	200	2	600	2 80	2	400	

* Two cuttings.

In considering these mixtures it must be borne in mind that the yields in 1923 and 1924 are made up wholly of grasses, the sweet clover having completed its period of growth in 1922. The yields for 1924 are included so as to show the relative persistency of the various grasses.

The results show that in 1922 the mixtures have all yielded slightly lower than the clover alone, except in the case of western rye grass. The heaviest yields for the two cropping years of 1922 and 1923 have been obtained from mixing two grasses with the clover. The presence of sweet clover, however, in the mixtures has brought up the yields considerably over those from each of the grasses sown alone.

Although the mixture with western rye grass has given the highest yield, this mixture is not altogether satisfactory. The rye grass is less aggressive than brome grass and is slower in getting started. During the first cropping year the rye grass does not seem to be able to compete with the clover, although it retains its stand and produces a good crop the following year. It is a bunch grass and is therefore less persistent than those grasses having more extensive root systems.

Brome grass, although yielding somewhat less in the mixture than rye grass, is better adapted to compete with sweet clover than most other grasses. It has a vigorous root system, and once established, persists until it becomes sod-bound. It grows quickly in the spring and consequently forms a large part of the mixture at the first cutting. It is interesting to point out, although the figures are not presented in the table, that the brome grass mixture gave the highest yield of all the mixtures at the first cutting in 1922.

The mixture with meadow fescue stands fairly high in yield, but as the fescue is slow in establishing itself, there is little of this grass in the first year's crop.

While timothy has shown up well in this test, its distribution in Manitoba is limited to certain sections. It might be generally stated, that where timothy can be successfully grown, legumes other than sweet clover will probably be grown to better advantage for hay and pasture.

In the mixtures containing two grasses, high yields have been harvested in the second cropping year. These yields are due mainly to the persistence of the brome grass in one case and to timothy in the other. This is borne out by figures obtained by taking the actual proportion of these grasses in the second cropping year.

The relative persistence of the grasses used when grown alone, is shown at the end of table 7. It is interesting to note that the brome grass still yielded a fair crop the third year after seeding. Timothy shows consistent yields over the three years and thus represents the persistency of this crop fairly well.

In summing up, it can safely be stated, that brome grass will make the most favourable mixture with sweet clover. It is able to withstand the aggressiveness of the clover, grows quick, and usually produces a crop one year longer before becoming sod-bound on account of having been seeded with the legume.

SWEET CLOVER IN INTERTILLED ROWS

Growing sweet clover in intertilled rows has not proven economical in the production of hay. In 1922 a series of plots were seeded down in rows varying from 6 to 42 inches apart. The plots in rows 30 inches apart and over, were cultivated at intervals throughout the seeding-down year, as well as during the earlier part of the cropping year. Table 8 summarizes:—

TABLE 8.—SWEET CLOVER IN ROWS

	Yield of cured hay per acre 1923	
	tons	lbs.
Rows in 6-inch drills.....	2	1,800
Rows 12 inches apart.....	2	1,800
Rows 30 ".....	2	599
Single rows 36 inches apart.....	2	260
Double " 33 ".....	2	437
Single " 42 ".....	2	15
Double " 42 ".....	2	562
Triple " 42 ".....	2	745

These figures show that growing sweet clover in rows more widely spaced than 12 inches results in decreased yields. It was observed that the plants grown in the intertilled rows were much coarser, and harvesting operations more difficult. On very weedy land, however, growing in intertilled rows affords the opportunity for clean cultivation. This method of growing sweet clover might prove satisfactory for seed production, or for hay where rainfall was the limiting factor in the production of forage.

INOCULATION

If neither sweet clover nor alfalfa has been grown on the land before, it will be necessary to inoculate the seed before seeding, in order to supply the young plants with the bacteria which are capable of extracting free nitrogen from the air.

The proper culture for artificial inoculation can be obtained from the Dominion Bacteriologist, Central Experimental Farm, Ottawa, or from the Manitoba Agricultural College. This culture is supplied in small bottles with full directions for its proper use. Satisfactory inoculation can also be accomplished by scattering fine, surface soil from an old alfalfa or sweet clover field over the seed which has been previously treated with some sticky substance such as furniture glue that will cause the soil particles to adhere. This latter method of inoculation has been outlined in Prof. Hanson's bulletin on legume inoculation, which states that by moistening the seed with a five per cent solution of glue, or about one-half pound of the glue to one gallon of water, sufficient soil particles containing the desired organisms will stick to the seed to bring about satisfactory inoculation.

Inoculation can also be brought about by spreading surface soil from an old alfalfa or sweet clover field on to the land to be seeded to sweet clover. This soil should be applied at the rate of from 100 to 200 pounds per acre, and harrowed in directly after application.

Artificial inoculation by pure culture is probably most generally used, and is to be recommended over the other two methods mentioned above.

SUMMARY

1. Sweet clover has become the most popular legume in Manitoba, because of its wide adaptation and its general usefulness as a farm crop.
2. Its value as a soil builder has been definitely proven.
3. This crop fits well into the common rotation systems of Manitoba.
4. Sweet clover can be depended upon for good yields of hay under almost any conditions of soil and climate.
5. As a pasture, sweet clover has a carrying capacity unequalled by most crops.
6. It is an abundant seed producer, on account of its lack of uniformity in ripening, the difficulty of removing the awns, and the percentage of hard seeds, considerable loss occurs through harvesting, threshing and cleaning.
7. Arctic sweet clover is recognized as a standard variety and has given favourable results.
8. Sweet clover can be made into silage, but because of its high water content, often becomes slimy unless care is taken to reduce the moisture by further maturity or by mixing with some dry roughage.
9. For the best results, early seeding, is recommended.
10. When a nurse crop is used, 10 to 15 pounds of clover seed per acre is a satisfactory rate of seeding.
11. Shallow seeding is preferable, provided the seed-bed is mellow and firm.
12. Seeding with a nurse crop at slightly less than the normal rate is most economical.
13. Cutting the crop in the early bud stage, leaving a 4- or 5-inch stubble will make the most palatable hay, and allow for a second growth.
14. Harvesting with the binder and curing in the sheaf will preserve the maximum amount of leaves and reduce the cost of handling the crop.
15. In a mixture with sweet clover, brome grass has advantages over other grasses.
16. Growing sweet clover in intertilled rows for seed production is recommended.
17. Inoculation of the seed is inexpensive and is advisable on the newer fields.

